Accepted Manuscript

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PII: S1359-8368(17)30949-6

DOI: 10.1016/j.compositesb.2017.07.028

Reference: JCOMB 5164

To appear in: *Composites Part B*

Received Date: 16 March 2017

Revised Date: 19 June 2017

Accepted Date: 25 July 2017

Please cite this article as: Del Zoppo M, Di Ludovico M, Balsamo A, Prota A, Manfredi G, FRP for seismic strengthening of shear controlled RC columns: Experience from earthquakes and experimental analysis, *Composites Part B* (2017), doi: 10.1016/j.compositesb.2017.07.028.

FRP for seismic strengthening of shear controlled RC columns: experience from earthquakes and experimental analysis

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Abstract

The high vulnerability of existing Reinforced Concrete (RC) structures, even to moderate seismic events, has been confirmed from recent post-earthquake surveys. Short and wall-like RC columns are particularly prone to brittle failures, governed by concrete crushing. To reduce the vulnerability of existing RC columns, the use of externally bonded Fibre Reinforced Polymer (FRP) reinforcement has been recognized as an effective method for preventing the aforementioned brittle failure and, hence, increasing members' lateral capacity and ductility. In the first part of this study, the results of an observational analysis on columns shear failures in RC buildings severely damaged after the L'Aquila earthquake are presented. The second part of the study presents and discusses the results of an experimental program carried out on seven short RC columns governed by shear failure under load reversal and compressive axial load. Both columns in "as built" configuration and strengthened in shear with discontinuous carbon FRP (CFRP) strips have been tested. Two classes of concrete have been used, in order to simulate structures with medium or poor material quality, and different external reinforcement ratios have been investigated. The specimens' responses have been analysed in terms of failure modes, strength/deformation capacity and strain distribution in CFRP strips.

Keywords: seismic retrofit; columns; FRP strengthening; shear failure.

1. Introduction

Recent post-earthquake surveys [1-3] revealed the high vulnerability of existing Reinforced Concrete (RC) structures, often designed for gravity loads only, even to moderate seismic events. Indeed, the lack of a proper seismic detailing and a wrong shear-flexure hierarchy often lead to columns brittle failures due to shear before attaining the flexural yielding. Furthermore, short and wall-like RC columns are commonly subjected to such a brittle failure, governed by concrete diagonal compression failure [4-7]. Semi-basements, band-type windows, knee beam stairs and masonry parapets can turn the behavior of